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Borbely, Daniel

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ORIGINAL ARTICLE

Limiting the distortionary effects of transaction taxes: Scottish stamp duty after the Mirrlees Review

Daniel Borbely

School of Business, University of Dundee

Correspondence
Daniel Borbely, School of Business, University of Dundee, 1–3 Perth Road, Dundee DD1 4JW, UK.
Email: DBorbely001@dundee.ac.uk

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Abstract

We investigate the distortionary effects of transaction taxes through a case study of the Scottish residential property market. We make use of four sources of variation in transaction tax rates present in recent Scottish tax systems: (1) jumps in tax liabilities at tax thresholds; (2) jumps in marginal tax rates at thresholds; (3) a tax announcement that created temporary tax saving opportunities; and (4) a shift to a more progressive transaction tax regime. Our results indicate that market participants are highly responsive to tax changes and are willing to change the price and timing of transactions when tax savings opportunities are present. We also find that progressive reform had a significant positive effect on transaction activity in the market segment where tax rates were reduced. However, the higher end of the market, where tax rates increased, was mostly unaffected by progressive reform, with the exception of the market for very expensive properties, where a negative effect is identified. Implications of our findings are that if governments want to make transaction tax regimes more efficient, progressive taxation might be a good way to limit distortionary effects, whilst also encouraging transaction activity in the lower end of the market.

KEYWORDS
behavioural responses to taxation, notches and kinks in tax systems, property markets, transaction taxes

JEL CLASSIFICATION
H21, H26, H30

1 | INTRODUCTION

Taxes on property transactions, also known as stamp duties, are a historic and common feature of tax systems in many European countries.[1] Transaction taxes are often considered inefficient as they discourage mutually beneficial property transactions, resulting in properties not being held by the individuals who value them most.[2] By disincentivising house moves at the margin, they may create distortions elsewhere, for example in the labour market by making property owners less geographically mobile, and thus reducing labour market flexibility.[3] Consequently, the European Commission recently recommended that countries move away from transaction taxation and implement more efficient ways of taxing housing.[4] In a similar vein, the recent Mirrlees Review[5] criticised the UK's stamp duty system and called for its abolition:

> 'Stamp duty has a long history in the British tax system, having first been introduced in 1694. It stems from a time when few other potential taxes were straightforward to implement, whereas the transactions on which stamp duty was levied were easy to identify and to measure. But, in the modern case of broadly based taxation, the case for maintaining stamp duty is very weak indeed [...] There is no sound case for maintaining stamp duty and we believe that it should be abolished.'

Yet, despite the frequent calls for their abolition, transaction taxes remain prevalent in European tax systems due to the reliance of government budgets on the associated tax revenues.[6] In this paper, we look at some policy options to limit the distortionary effect of transaction taxes through a case study of recent tax reforms in Scotland.

The Scottish Government inherited the UK-wide stamp duty regime but the Scotland Act of 2012 included stamp duty among various new devolved taxes. While abolition of stamp duty was not permissible under the Act, reform of the system to address elements of Mirrlees' critique was now an option.[7] Accordingly, in 2015, the government introduced a new, Scottish transaction tax to satisfy two main policy objectives: (1) to reduce distortionary aspects of previous stamp duty regimes and (2) to make the tax system more progressive in order to make taxation more in line with the ability to pay and encourage property market activity in the lower end of the market. Tax reform in Scotland resulted in several sources of variation in transaction tax rates. In our analysis, we exploit these sources of variation to investigate the ways in which transaction taxes can distort property market behaviour, and we evaluate the efficacy of recent reforms in limiting these distortions. Three specific policy changes make Scotland a particularly interesting case study.

First, until December 2014, the Scottish residential property transaction tax system was characterised by a 'notched' structure – under this structure, once a given price threshold is reached, the appropriate tax rate is payable on the entire purchase price of the property, leading to discontinuous jumps in tax liability at threshold values (also referred to as price notches). Under this regime, transactions similar in terms of value incur very different tax liabilities – discouraging higher taxed transactions to a much larger extent than similarly valued but lower taxed transactions, creating large

[1] See European Commission (2018) for an overview.

[2] Johansson et al., 2008; Mirrlees et al., 2011.

[3] According to Hilber and Lyytikäinen (2017), a 2 per cent increase in stamp duty at the £250k threshold reduces the annual rate of mobility by 2–3 percentage points.

[4] European Commission, 2015.

[5] Mirrlees et al., 2011.

[6] See Johannesson-Linden and Gayer (2012).

[7] Abolishing stamp duty was not a feasible policy option for the Scottish Government. The Scotland Act 2012, which legislated devolved tax policy options for Scotland, requires stamp duty to be replaced with an equivalent transaction tax that involves interest on land (see Scottish Government, 2013a).

incentives to transact at prices just below the threshold.[8] In December 2014, the notched structure was removed and a 'kinked' Stamp Duty Land Tax (henceforth SDLT) regime was introduced UK-wide, including in Scotland.[9] Soon after this, the Scottish Government announced the 1 April 2015 introduction, and the precise tax schedule of a new Scottish transaction tax, the Land and Buildings Transaction Tax (henceforth LBTT). In a similar vein to the new UK SDLT, the LBTT has a kinked tax schedule where only the marginal tax rate jumps discontinuously at threshold prices so the tax liability is a continuous function of price. Economic theory predicts that agents respond to both notches and kinks by bunching, that is, increased transaction activity occurs just below (or, in the case of kinks, around) tax thresholds. Bunching should occur to a much larger extent in notched tax systems due to the abrupt jump in tax liability at notches.[10] Using the examples of previous and current Scottish tax regimes, we are able to investigate the distortionary effect of notches and kinks on property market activity, and to assess whether replacing the notched tax regime with a kinked one was a sensible policy to reduce property market distortions. To do this, we employ a bunching estimator methodology[11] to construct a counterfactual density of transactions at different prices and to compare this with the observed distribution of transactions.

The second margin for property market distortions we investigate in this paper is related to the early announcement of LBTT, which created a temporary opportunity for home buyers in Scotland to save on taxes paid. The LBTT has a more progressive schedule in comparison with the UK SDLT regime it replaced; that is, higher priced transactions are taxed at higher rates, with lower rates applied in some lower price ranges. As a consequence, the announcement of the LBTT created a time notch in the tax schedule at 1 April. Depending on the price of the property, tax liabilities were lower (or higher) if transacting before this date than after, creating large incentives for agents to strategically time their transactions where feasible. The variations in tax rates around this time notch provide us with the opportunity to estimate distortions to property market behaviour in the months surrounding the policy change, and to determine how responsive property transactions in Scotland were to temporary savings opportunities. We estimate responses to the time notch by comparing observed time trends in actual transaction volumes with counterfactual time trends, constructed using predicted values for monthly transaction volumes from a fixed-effects regression.

Finally, the introduction of the LBTT resulted in a more progressive transaction tax system in Scotland. The reform had different effects on tax rates throughout the price distribution. Effective average tax rates were: (1) unaffected for the bottom segment below £125k; (2) decreased for the £125k to £380k price range; and (3) increased for the higher end of the market covering transactions over £380k.[12] The government's objective with progressive reform was to encourage transaction activity at the lower end of the market and to bring tax liabilities more in line with the ability to pay.[13] In effect, progressive reform uses tax increases in the higher end of the market to pay for tax cuts at the lower end.[14] Ideally, the reform is intended to result in increased transaction activity for the market segment where taxes were cut, and in little or no response from the market segment where tax rates increased. To assess the extent to which progressive reform has accomplished these goals in Scotland, we look at the reform's effects across the price distribution and make use of the variation in

[8] Mirrlees et al., 2011; Best and Kleven, 2018.

[9] In a kinked system, tax rates are applicable on the share of the property price above threshold values. It is worth noting that it was the Scottish Government who initially announced the planned change to a kinked system in October 2014. The UK government applied the UK-wide change in December partly in response.

[10] Kleven, 2016.

[11] Chetty et al., 2011; Best and Kleven, 2018.

[12] Effectively, because of the short period during which the 'kinked' SDLT regime was active, and the possibility that market activity in this period was affected by the timing responses outlined above, the reform can be considered as a shift from the 'notched' SDLT to the LBTT.

[13] Scottish Government, 2013b.

[14] The Scottish Government planned the policy change to be 'broadly' revenue neutral, although there was no indication of how this was to be achieved upon setting the actual bands and rates for the LBTT; see Scottish Government (2013a, 2013b).

tax rate changes to investigate the permanent effect of progressive reform. We do this by employing a difference-in-differences strategy where we use the unaffected price range as the comparison (control) group and estimate relative changes in transaction activity in affected (treated) ranges. To assess whether the reform had a different effect on different parts of the price distribution, we analyse market segments where tax rates decreased, and segments where tax rates increased, separately.

Our analysis of the effects of transaction taxation on the property market makes use of a particularly rich data set containing all residential property transactions in Scotland. These data allow us to determine the price and date of each individual residential property transaction, and to control for property and market characteristics. We present three main findings.

First, we find that the 'notched' design of the previous Scottish stamp duty system was highly distortionary to property market behaviour in that it led to the bunching of transactions below tax thresholds; the current 'kinked' system still results in bunching, but this is small and only occurs at a subset of thresholds. Second, we find that the temporary opportunity for tax savings, created by the announcement of future tax reform, did lead to a substantial behavioural response, as many home buyers changed the timing of their transactions to save on the associated tax liabilities. Finally, our evidence suggests that progressive transaction tax reform in Scotland led to a substantial increase in transaction activity in the lower end of the market, where tax rates decreased; had no discernible effect on most price ranges where tax rates increased; and only had a significant negative effect on the market for very expensive properties. From a policy perspective, our findings suggest that the Scottish Government's objectives with respect to reforming the stamp duty system were accomplished: the shift to a kinked tax schedule minimised distortions from bunching responses, while progressive reform was successful in encouraging market activity in the lower end of the market (without distorting activity in the higher end to a large extent). Nonetheless, significant distortions persist because of the continued re-emergence of time notches upon announcement of new policies.

Our paper makes several contributions to the empirical literature on the effects of transaction taxes on property market behaviour. First, while a number of recent studies find evidence of distortions created by notched transaction tax regimes,[15] our study is the first one to look at the distortionary effects of kinks, and to investigate the transition from notched to kinked tax schedules. We also contribute to the literature on the effects of time notches. Prior case studies find evidence of timing responses to the pre-announced end date of temporary fiscal stimulus[16] and preceding changes in flat tax rates[17] but our study is the first one to look at the effects of time notches across the price distribution and especially on the market for expensive properties. Lastly, we contribute to the literature on the permanent effects of transaction taxation[18] through an analysis of progressive transaction tax reform in Scotland. Uniquely in the literature, our case study allows us to look at the effects of progressive transaction tax reform on the property market, and to assess the heterogeneity of effects across the price distribution. Moreover, previous UK case studies on the effects of transaction taxation use variation in tax rates from temporary tax cuts for cheaper properties during periods of economic downturns.[19] These studies are therefore mostly focused on the effects of fiscal stimulus on a set of lower priced properties, while our study focuses on the effects and policy implications of comprehensive tax reform throughout the price distribution.

The remainder of the paper is organised as follows. Section 2 provides the relevant policy background. Section 3 describes the data. Section 4 outlines our empirical approach and summarises our results. Section 5 provides a discussion of our findings. Section 6 concludes.

[15] Kopczuk and Munroe, 2015; Best and Kleven, 2018; Slemrod, Weber and Shan, 2017.

[16] Best and Kleven, 2018.

[17] Fritzsche and Vandrei, 2019.

[18] Besley, Meads and Surico, 2014; Slemrod et al., 2017; Best and Kleven, 2018; Fritzsche and Vandrei, 2019.

[19] Besley et al., 2014; Best and Kleven, 2018.

2 | BACKGROUND

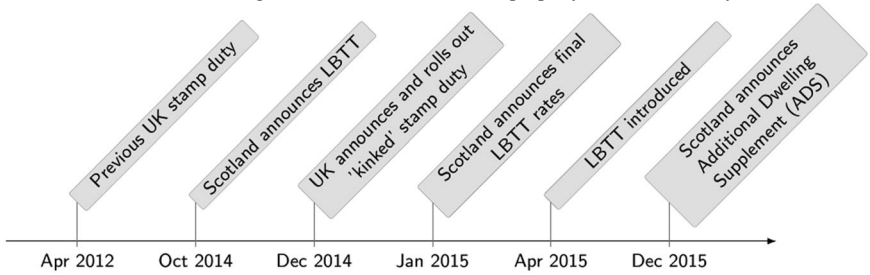
Tax on property transactions, also known as stamp duty, is paid by buyers of properties every time a new transaction takes place. Transaction tax rates are different for residential and commercial transactions. In our analysis, we consider the residential property market and the corresponding tax system. In Scotland, the residential transaction tax system has gone through several changes in recent years. We consider as the starting period of our analysis the previous UK stamp duty system as at April 2012.[20] The timeline of relevant changes to the Scottish property transaction tax system is presented in Figure 1.

In Scotland, the UK stamp duty system (known as Stamp Duty Land Tax, or SDLT) was in place until the introduction of the Land and Buildings Transaction Tax (LBTT) in April 2015. Initially, Scotland announced the introduction of the LBTT in October 2014. However, in December 2014, the UK government changed the SDLT system from the previous 'notched' to a 'kinked' regime, and altered the rates and threshold values. This tax regime continued to apply to Scotland until April 2015. After the UK-wide change in the stamp duty system, the Scottish Government announced, in January 2015, final LBTT rates and thresholds to be in place from 1 April 2015. Later in 2015, they also announced the introduction of the Additional Dwelling Supplement (ADS), a 3 per cent surcharge on second properties priced over £40,000. In effect, three transaction tax regimes were in place in Scotland within our sample period of April 2012 to December 2017:

1. the previous (UK-wide) SDLT regime with the notched structure from April 2012 to December 2014;
2. the new (UK-wide) SDLT regime with the kinked structure from December 2014 to March 2015;
3. the LBTT regime, also following a kinked structure but more progressive than the UK SDLT, from April 2015.

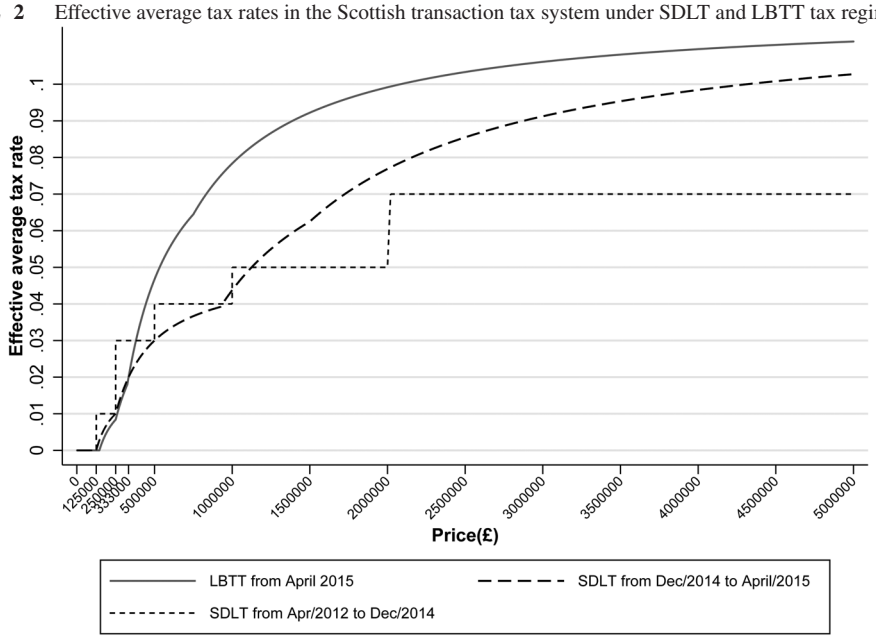
Effective average tax rates under each regime are compared in Figure 2. Key features and changes in recent transaction tax regimes in Scotland emerge from these comparisons. First, the notched structure of the previous SDLT regime resulted in large jumps in both effective average and marginal tax rates at threshold values (price notches). After tax reform, the UK SDLT and Scottish LBTT both follow a kinked tax schedule. Second, the introduction of the LBTT created a time notch in the Scottish transaction tax system at 1 April 2015. In Figure 2, the area between the dashed and solid lines highlights the differences in tax rates payable before and after this date. Being taxed under SDLT before 1 April, buyers of properties in Scotland had the incentive to change the timing of transactions and be taxed under the more generous tax regime. Finally, the introduction of the LBTT in Scotland has made the transaction tax regime in Scotland more progressive – with lower tax rates at low prices,

FIGURE 1 Timeline of recent changes to the Scottish residential property transaction tax system



[20] This period also corresponds to the end of a two-year period of first-time buyers' relief. The stamp duty system had different bands before, and we would like to avoid bias from this.

FIGURE 2 Effective average tax rates in the Scottish transaction tax system under SDLT and LBTT tax regimes



and higher tax rates at high prices. We analyse each of these features, and the related policy changes, in Section 4.

3 | DATA

To analyse the effect of transaction taxes on the Scottish property market, we use a data set containing the universe of Scottish property transactions from the Registers of Scotland (ROS).[21] The ROS is a non-ministerial government department responsible for compiling public registers in Scotland.[22] Our data set includes all property transactions in Scotland during the sample period (April 2012 to December 2017). It also contains the types, addresses, postcodes, coordinates and postcode areas of properties, along with, most importantly, the date and price at which they were sold. As our analysis focuses on the residential property market, we restrict our sample to include only residential transactions. Furthermore, we exclude transactions for which no price was given, or for which nonsensical values were given.[23] This latter group of transactions constitutes roughly 0.4 per cent of our raw data. We observe when a property is transacted through the variable 'date of entry', which notes the date at which ownership rights were exchanged between the buyer and the seller. In our sample period, we have 716,275 property transactions in Scotland, and the mean transaction price is £165,073.40.

4 | IDENTIFICATION STRATEGY AND RESULTS

Our empirical investigation concerns the following margins for distortions in recent Scottish transaction tax regimes: (1) price notches in the previous stamp duty system; (2) kinks in the LBTT

[21] Crown copyright. Material is reproduced with the permission of the Keeper of the Registers of Scotland.

[22] Registers of Scotland. Economic and Social Research Council. *Registers of Scotland All Sales Data, 2019* [data collection]. University of Glasgow - Urban Big Data Centre.

[23] Possible reasons for 'no price' transactions include ownership changes due to divorce settlements or inheritance.

system; (3) the time notch at the 1 April introduction of the LBTT; and (4) the shift from the previous stamp duty system to the more progressive LBTT system.

In this section, we estimate how responsive the property market activity in Scotland was to changing tax rates along each of these margins. While we employ distinct identification strategies for each case, we also control for biases arising from their combined effect on the property market.

4.1 | Estimating the property market effects of notches and kinks in Scottish transaction tax regimes

4.1.1 | Estimating the effects of price notches in the previous SDLT system

The previous (UK-wide) SDLT system was in place between April 2012 and December 2014 (see Section 2).[24] Transaction taxes were charged on the entire purchase price of the property creating 'price notches' in the tax schedule. At price notches, threshold prices where average tax rates change, both the marginal tax rate and tax liability jump discontinuously creating large incentives for buyers to transact at prices just below a given tax threshold and avoid the abrupt increase in taxes payable. These incentives may lead to the bunching of transactions at prices just below notches. Bunching responses might be accentuated by the fact that notches create particularly salient reference points for agents to strive towards.[25]

Tax rates and thresholds for the previous SDLT system are summarised in Table 1, along with the jump in tax liability, corresponding to a £1 increase in the transaction price, at each price notch. It is evident from the numbers presented here that the Scottish system has created particularly large and salient incentives to reduce transaction prices in the regions of notches, as doing so even by a small amount could lead to a monetary saving of several thousand pounds.[26]

In Figures 3 and 4, we plot the density of property transactions at different prices. The figures aggregate transactions in Scotland for the entire period during which the previous stamp duty system was in place. These plots already provide us with visible indications of bunching, that is, a higher density of property transactions just below price notches (and lower density just above). We can observe spikes in the density of transactions corresponding to the £125k, £250k and £500k price notches, and there is also some bunching around the £1 million notch, though this does not seem to be

TABLE 1 Previous UK stamp duty (SDLT): tax schedule and price notches

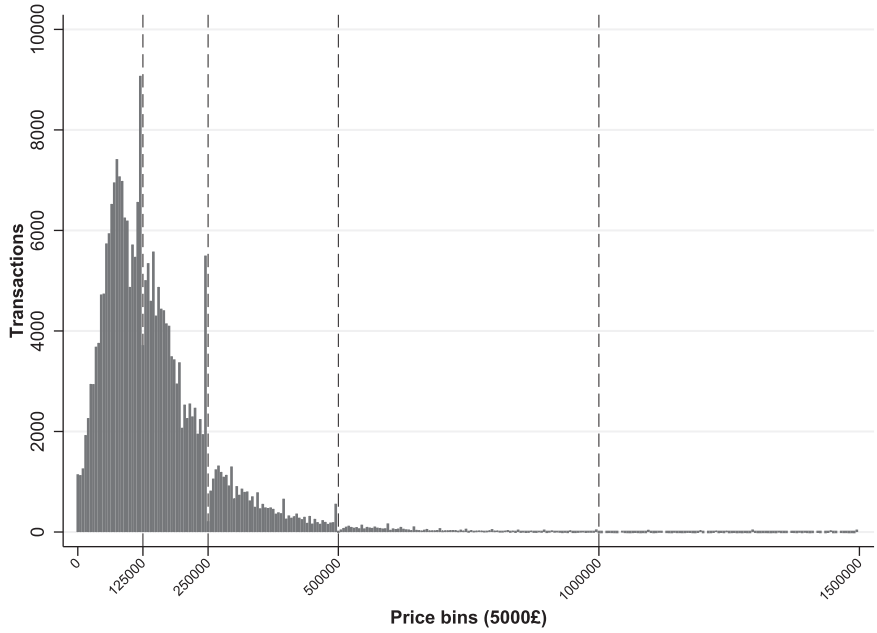
Price	Tax rate	Jump in liability at threshold
£0–125k	0%	£0
£125–250k	1%	£1,250
£250–500k	3%	£5,000
£500k–1 million	4%	£5,000
£1–2 million	5%	£10,000
Over £2 million	7%	£40,000

[24] As noted in Section 2, the beginning of this period corresponds to the end of the period for first-time buyer's relief. The anticipated end of the relief period may have encouraged agents to transact before the new tax regime was implemented, potentially resulting in a number of missing transactions in the months after April 2012. This is unlikely to bias our empirical analysis below, as we aggregate transactions over the entire previous stamp duty period, which means that the timing effect in the first month or two will likely be negligible on aggregate. Nonetheless, as a robustness check, we performed our analysis below excluding the first three months of the previous stamp duty period from the sample. Dropping these months had no discernible effect on our results.

[25] Kleven, 2016.

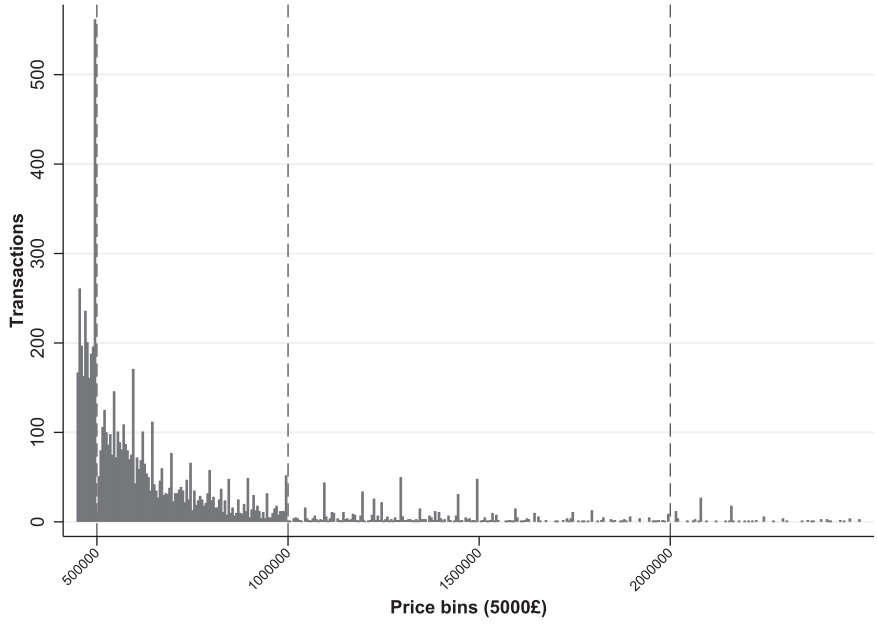
[26] The size of the monetary tax savings is important because optimisation frictions, such as the cost of renegotiating the transaction price, might dissuade buyers from changing their behaviour if the realised tax saving from doing so is small (Kleven, 2016; Slemrod et al., 2017).

FIGURE 3 Density of transactions at different prices in Scotland: previous stamp duty (SDLT) system from April 2012 to December 2014



Note: Vertical dashed lines indicate threshold values where tax rates change (price notches).

FIGURE 4 Density of transactions at different prices in Scotland (higher price range): previous stamp duty (SDLT) system from April 2012 to December 2014



Note: Vertical dashed lines indicate threshold values where tax rates change (price notches).

outstanding relative to the price neighbourhood. Note, however, that bunching can occur for reasons other than the incentives created by notches, for example by salient reference points at round number prices.[27] To disentangle bunching responses to price notches, we therefore need to control for other factors that could influence the density of transactions throughout the price distribution. We do this using the bunching estimator approach outlined in Best and Kleven (2018). This approach relies on the estimation of a counterfactual density of transactions – what the density of transactions would look like in the absence of price notches at threshold values. We estimate counterfactual transaction densities by fitting a fifth-degree polynomial to the data, using the wider region of the price notch but excluding observations in a small range around the notch.

More specifically, the counterfactual distribution is estimated using the following regression model,

$$t_i = \gamma_0 + \sum_{j=0}^{5} \gamma_{1j} p_i^j + \sum_{r=1}^{3} \gamma_{2r} R_{ri} + \mu_i, \tag{1}$$

where t_i are the number of transactions in price bin i and price bins are £5,000 wide.[28] The second term on the right-hand side is a fifth-degree polynomial of the transaction price p aimed at approximating the relationship between an increase in price and the density of property transactions. The third term is a set of indicator variables for transactions at round number prices for multiples of £10,000, £25,000 and £50,000. This is to control for possible bunching at round prices, and for transactions being more frequent at some round prices than others.[29] We exclude all transactions from the range around the price notch so that bunching around the notch in the actual data does not affect our counterfactual distribution.[30] The lower bound of the excluded region is selected to be at the price bin where the slope of the actual density of transactions changes from negative to positive (excess bunching starts). The upper bound of the excluded region is where the slope of the empirical distribution of transactions changes from positive to negative (missing mass ends). To assess whether the density of transactions increased below the price notch (and dropped above), we plot the predicted (counterfactual) transaction density for each price bin and compare it to the actual transaction density. The plots are summarised in Figure 5.[31] The vertical difference in transaction density between actual (solid line) and counterfactual (dashed line) plots in the region of the price notch should be indicative of the presence and extent of bunching responses. In our case, two estimates are of interest: (1) the excess bunching, or increased transaction density relative to the counterfactual, just below the price notch; and (2) the missing mass, or reduced transaction density, just above the notch. These estimates are presented in Table 2, where excess bunching and missing mass estimates are scaled relative to the average counterfactual density in the excluded price range.

There are two limitations of this analysis that are worth noting here. First, the bunching estimator procedure only yields a 'partial counterfactual', as extensive margin responses (to buy or not to buy a property) are not incorporated.[32] Second, estimation of the number of missing transactions (missing mass) above price notches is likely to be imprecise as it is highly sensitive to parametric

[27] Kleven, 2016.

[28] In similar studies such as Best and Kleven (2018) and Slemrod et al. (2017), £100 (or $100) price bins are used. However, in the case of the Scottish property market, if aggregated at that level most price bins contain zero transactions as most transactions tend to occur at large round numbers. For this reason, we decide to aggregate at the £5,000 level.

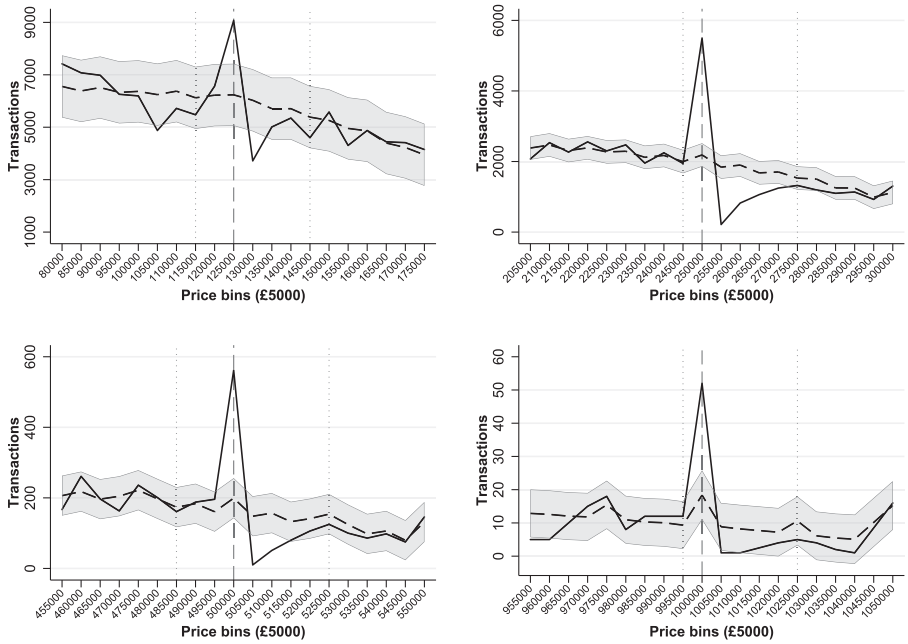
[29] We estimate round number bunching using the segments of the empirical distribution that are not near price notches (not in the excluded range).

[30] Our estimates are robust to changing the size of the excluded region (even asymmetrically), and are also robust to the order of the polynomial used in the model.

[31] In the neighbourhood of the £2 million notch, there are very few transactions and the density follows an idiosyncratic pattern. We therefore cannot rely on our counterfactual estimation and we do not analyse bunching around this notch.

[32] Kleven, 2016.

FIGURE 5 Bunching at price notches in the previous SDLT system



Note: Solid lines represent the actual density of transactions at different prices. Dashed lines represent the counterfactual density of transactions, calculated using predicted values from the regression model outlined above. The grey shaded area around the counterfactual represents the 95 per cent confidence interval of the counterfactual estimates. The actual distribution spanning the confidence intervals is indicative of a significant bunching (or missing mass) estimate. The vertical dashed lines represent the upper and lower bounds of the excluded region around the notch. The lower bound of the excluded region is selected as the point where the slope of the actual density of transactions changes from negative to positive. The upper bound of the excluded region is selected as the point where the actual density changes slope from positive to negative.

TABLE 2 Bunching at price notches under the previous SDLT system

Price notch	Excess bunching		Missing mass	
£125k	0.541***	(0.103)	0.706***	(0.104)
£250k	1.879***	(0.458)	2.433***	(0.652)
£500k	2.586***	(0.198)	2.473***	(0.185)
£1 million	3.398***	(0.589)	2.625	(2.542)

Note: Excess bunching is estimated from the excess bunching price bins (excluded region) just below a given notch and is relative to the counterfactual density in the excluded region. The missing mass is calculated from the excluded range above the notch and is also relative to the average counterfactual density in the excluded region. Standard errors (in parentheses) are obtained through a bootstrapping procedure (see Best and Kleven, 2018). ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

assumptions.[33] Similarly to Best and Kleven (2018), we can largely ignore these concerns based on the size, significance and robustness of the bunching response observed near price notches (see below). This is because inference in our case is predicated upon finding evidence of bunching, per se, and does not rely on precise estimates of the components of bunching responses.

Except for the £125k price notch analysis, our counterfactual estimates fit actual data relatively well in the price regions not near the price notches. For all price notches, we find strong evidence of bunching behaviour; the actual densities below price notches are significantly (as indicated by the 95 per cent confidence interval around our counterfactual estimates) higher than counterfactual predictions in all cases. In the £5,000 price bin just under the price notch, we estimate that, in

[33] Kleven and Waseem, 2013; Kopczuk and Munroe, 2015.

comparison with the counterfactual, transaction volumes are approximately 1.5, 2.5, 2.8 and 2.8 times larger for the notches at £125k, £250k, £500k and £1 million, respectively. We also note that in all our estimations the higher density of transactions under the notch is followed by a lower density of transactions at prices just above. The estimates summarised in Table 2 indicate that the missing mass above price notches tends to be similar in size, or in some cases even larger, than the excess bunching just below, although none of these differences is statistically significant. According to Kopczuk and Munroe (2015), the larger missing mass relative to excess bunching may be due to extensive margin responses (i.e. buyers and sellers not transacting at all in the region of the notch). Looking at Figure 5, we can also see that the missing mass spans a £15,000–20,000 range above each price notch, suggesting that some agents were willing to reduce the transaction price by much more than the increase in tax liability at the threshold (see Table 1). In their theoretical model, Best and Kleven (2018) stipulate that this phenomenon is likely a result of downpayment-constrained home buyers, with high loan-to-value ratios on their mortgages, being particularly responsive to transaction tax changes. These home buyers are likely to be more sensitive to tax changes because they need to pay transaction taxes upfront and cannot package these taxes into mortgage loans.

Overall, our findings are indicative of agents manipulating prices to fall just under the relevant tax threshold. Our results show that the Scottish property market was highly responsive to the presence of price notches under the previous SDLT system. According to our estimates, the overall tax revenue leakage from the behavioural response in the excluded regions is approximately £32.77 million (£11.92 million annually), or 22.4 per cent of total counterfactual tax revenues in these price ranges.[34] Note, however, that this number is based on a counterfactual estimate that does not incorporate extensive margin responses while the actual density of transactions likely does. In other words, part of the revenue leakage estimate is due to a lower number of total transactions (the extensive margin response) and not only due to the same transactions occurring at lower prices (the price effect). We estimate the revenue leakage from the price effect only by scaling our results so that our excess bunching and missing mass are equal in the excluded regions around notches and the same number of transactions occur in both the actual and counterfactual distributions.[35] Calculated this way, our estimates suggest a revenue leakage of £26.1 million (£9.49 million annually) in the excluded regions around notches.

4.1.2 | Estimating the effects of kinks in the LBTT system

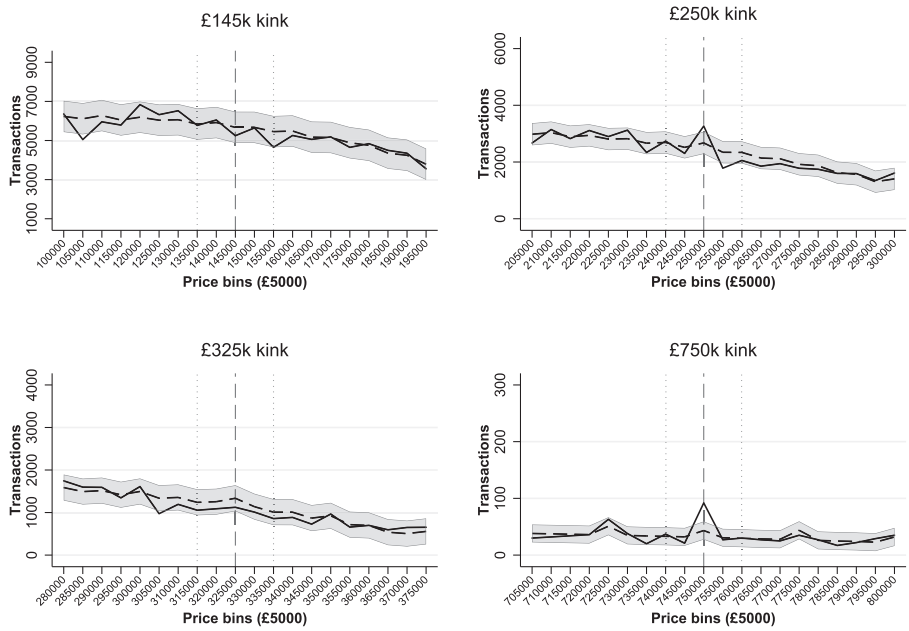
By changing the way in which tax liabilities are calculated at different prices, the LBTT reform effectively replaced the notches in the Scottish transaction tax schedule with convex kink points.[36] Contrary to notches, at (convex) kink points, only the marginal tax rate jumps discontinuously while tax liability is a continuous function of price. Kinked tax schedules lead to a change in the slope of agents' budget line at kink points. Agents in the region just above kink points will be able to attain a higher indifference curve (tangent to the pre-kink budget line) and will move around the kink, leading to bunching. Convex kinks should not however lead to a missing mass above kink points as agents move down the new budget line in response to higher marginal tax rates in order to fill up the 'hole'. Consequently, in a kinked transaction tax schedule, we should observe bunching at prices around tax thresholds, but no missing mass at prices just above. In order to assess whether this is the case under the current Scottish transaction tax system, we use the bunching approach from the previous section to

[34] This estimate is based on counterfactual tax revenues under a tax system with unchanged tax rates and thresholds, but no bunching present, as illustrated by the dashed lines in Figure 5.

[35] The scaling is done by multiplying the average tax saving with the average of the excess bunching and missing mass figures.

[36] Note that while the UK-wide reform to the SDLT system has already replaced the notches in December 2014 (see Section 2), we do not consider this period in our bunching analysis as transaction activity was highly affected by timing responses (see Section 4.2) during the few months the new UK SDLT was in place in Scotland.

FIGURE 6 Bunching at kink points under the LBTT system



Note: Solid lines represent the actual density of transactions at different prices. Dashed lines represent the counterfactual density of transactions, calculated using predicted values from the regression model outlined above. The grey shaded area around the counterfactual represents the 95 per cent confidence interval of the counterfactual estimates. The actual distribution spanning the confidence intervals is indicative of a significant bunching (or missing mass) estimate. The vertical dashed lines represent the upper and lower bounds of the excluded region around the kink point. The excluded region is £10k wide on either side of the kink point.

estimate counterfactual transaction densities near the kink points in the LBTT schedule.[37] The LBTT rates change at threshold values of £145k, £250k, £325k and £750k, corresponding to nominal tax rates of 2 per cent, 5 per cent, 10 per cent and 12 per cent, respectively (see Section 2 and Figure 2). Bunching estimates for the price regions near these kink points are summarised in Figure 6.

As shown in Figure 6, bunching responses under the kinked LBTT system are much less substantial in comparison with those under the notched schedule of the previous SDLT. In fact, we find no evidence of bunching for the £145k and £325k kink points, whereas we find a small bunching response at the £250k kink point, where the excess bunching estimate is 0.269 (standard error, SE: 0.091), and a more substantial bunching response at the top rate threshold of £750k, where our excess bunching estimate is 1.268 (SE: 0.237). Missing mass above the kink can only be observed for the £250k threshold, but this is relatively small with a missing mass estimate of 0.312 (SE: 0.101).

The findings of bunching responses around kink points, and no missing mass above them, are consistent with the stipulations of the theoretical literature, particularly for kink points at round numbers that provide salient reference points for agents to strive towards.[38] Note, however, that our counterfactuals predict only minimal round number bunching, especially in comparison with the notched case above, at the threshold prices of £250k and £750k (see Figure 6). This is likely a consequence of the empirical distribution (see Figures A.1 and A.2 in the online Appendix) being relatively smooth outside the price regions near kink points (this is the price region we use to estimate round number bunching). Moreover, bunching near £500k and £1 million does not seem to be outstanding when looking at the empirical distribution, and adding a round number dummy for

[37] The data used for this analysis are from the period June 2015 to December 2017. The first two months of the LBTT period were excluded to avoid the timing responses to the new tax regime interfering with our results.

[38] Saez, 2010; Kleven, 2016.

multiples of £250k does not change our bunching estimates around kink points to any degree. As we observe no discernible bunching response around the $145k and £325k kinks, it is possible that the bunching observed around other kink points is due to those thresholds being particularly salient.

4.2 | Estimating the effect of a time notch at the end of the LBTT announcement period

As previously explained in Section 2, in January 2015, the Scottish Government announced the 1 April introduction of the LBTT, a tax regime that is more progressive than its predecessor, the UK SDLT. The announcement period, which lasted from 21 January 2015 until the end of March 2015, provided buyers of properties in Scotland with a temporary savings opportunity.[39] Those aiming to transact in the £125–333k price range, where tax liabilities are lower under the LBTT than under the previous tax system, had the incentive to delay transactions and wait to be taxed under the LBTT. However, in the range above £333k, buyers had the incentive to bring transactions forward and pay lower taxes under the previous system. Note that while savings from delaying transactions in the £125–333k price range are relatively low, savings from bringing transactions forward in the higher price range can be almost 4 per cent of the property value (see Figure A.3 in the online Appendix). However, delaying transactions might be easier than bringing them forward, given the time it takes to move from offer to ownership on the property market.[40] Based on this, we can form the following expectations.

1. *In the price range £125–333k*: lower than average transaction volumes in the months preceding April 2015 due to buyers delaying transactions, and higher than average transaction volumes during and after April 2015 due to those transactions taking place under the LBTT. As less time is required for sellers to 'hold' properties, delaying transactions should become decreasingly costly as we move towards April, meaning the decline in transaction activity should be gradual in the preceding months. After 1 April, transaction activity should increase sharply to return to normal levels as there is no real incentive to delay transactions any further.
2. *In the price range above £333k*: higher than average transaction volumes in the months preceding April 2015 due to buyers bringing transactions forward, and lower than average transaction volumes during and after April 2015 due to those transactions not taking place under the LBTT. The timing response should be strongest just before April, as there is no incentive (and potentially no time) to bring transactions forward to many weeks before this. After 1 April, we should then expect a gradual decline in transaction numbers as transactions predicted for the next months no longer take place.

In the months before April 2015, there is a clear drop in transactions in the lower price range, although property market activity is generally low at this time of the year and it is difficult to disentangle seasonal effects from the effect of the behavioural response (see the top panel of Figure A.4 in the online Appendix). However, in the price range above £333k (see the bottom panel of Figure A.4), bunching around the time notch is evident from the unusually high number of transactions in March 2015.

Our empirical strategy aims to isolate the timing responses arising from temporary savings opportunities from the daily, monthly and yearly time trends affecting the property market. Analogously to our approach in Section 4.1, we estimate counterfactual monthly distributions of property transactions over time. We do this by fitting a fixed-effects time-series model to the empirical data, excluding the months around the LBTT introduction in April 2015 that might be

[39] Also, the initial (October 2014) announcement (see Section 2) of the LBTT might have already led to tax planning behaviour from agents anticipating a tax change in April.

[40] According to Besley et al. (2014), the time from first offer to change in ownership for UK properties is usually under 60 days.

affected by reduced/increased transaction volumes due to timing responses. This counterfactual time trend approximates a scenario where no tax savings opportunities are present during the LBTT announcement period. We then compare the counterfactual time trends to actual time trends to estimate the effect of behavioural responses on transaction numbers in the months around April 2015. Our counterfactual is based on the following fixed-effect regression model:

$$t_{iym} = \gamma_0 + \theta_y + \theta_m + \theta_{dow} + \theta_i + \epsilon_{iym}. \quad (2)$$

Here, t_{iym} are transaction volumes in price bin i, year y and month m, and θ_y, θ_m, θ_{dow} and θ_i are fixed-effects for year, month, day of the week and price bin, respectively.[41] From this estimation, we exclude the announcement period (December 2014 to April 2015) and the three months following the introduction of the LBTT.[42] Our sample period covers the previous SDLT system (from April 2012) and the LBTT system until the announcement of the Additional Dwelling Supplement (ADS), a tax on second properties, in December 2015.[43] Our model is estimated for both price ranges, £145–333k and above £333k.[44] We plot the counterfactual time trends estimated using equation 2 against the actual time trends in transaction volumes. We associate the vertical difference between actual and counterfactual time trends (near April 2015) with the timing response to the LBTT introduction. Our results are presented in Figures 7(a) and 7(b).

In the £145–333k price range, there seems to be some evidence that buyers delayed transactions in response to the anticipated introduction of the LBTT (see Figure 7a). In February and March, transaction volumes are (significantly) below counterfactual ones, but the actual level of transactions is not low in comparison with previous winters. The effect therefore does not seem to be very large, a decrease in transactions of roughly 16–17 per cent in the months February and March. Nevertheless, when compared with the size of the tax saving from delaying (average tax savings are roughly £397, or 0.17 per cent of average property value in this price range), this response is considerable, a 42.7 per cent reduction in transaction activity per £1,000 reduction in tax liability. Somewhat surprisingly, there does not seem to be a large spike in transactions immediately after the end of March, although there is a spike in transactions during the summer. One possible explanation for this is that home buyers only started the procedure to buy new properties in or after April, and so those transactions were completed only during the following months.

In the price range above £333k, the effect of the behavioural response of bringing transactions forward is evident in the comparison of the time trends (see Figure 7b). Compared with the counterfactual, March 2015 has approximately three times as many transactions, indicating a large change in transaction volumes in response to the introduction of the LBTT. In this market segment, the increase in transaction volumes per £1,000 saved is around 26 per cent.[45] Conversely, transaction levels in April and May are quite low (buyers who transacted in March do not transact in these months) although the market does seem to recover by June. Indeed, the missing mass of property transactions

[41] We include price range fixed effects to control for the presence of notches near some price ranges in the early part of the sample period. Day of the week fixed effects are based on the total number of each day of the week within each month.

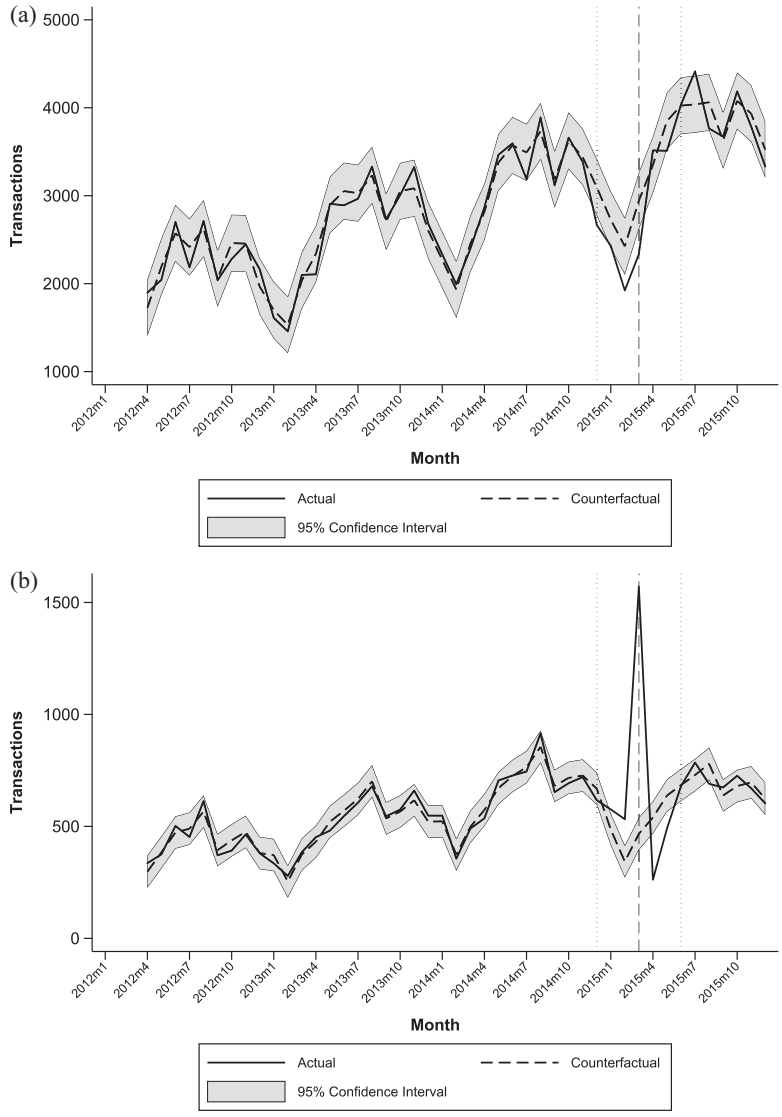
[42] Our results do not change when four months are excluded.

[43] The ADS was announced during the last days of November, but because it was only introduced next April, we assume no behavioural responses until 2016 (there would not be enough time to file and process property transactions in 2015).

[44] We exclude transactions between £125k and £145k so that our estimates are not biased by the removal of the £125k price notch in December 2014. As the notch has led to a lower transaction density just over £125k, its removal might have led to increased transaction volumes in the above price ranges.

[45] This calculation is based on the average tax saving of £9,010 in this price range. Calculations of tax savings are based on tax savings for the actual transactions that took place during the announcement period (and the two months after). Once taking into account the average tax savings from re-timing, the timing response in the lower end of the market seems to be larger than that in the higher end. Note, however, that delaying transactions should be a lot less costly than bringing them forward, the two responses are therefore not directly comparable. The estimates for the two price ranges are also not directly comparable because (1) there are more transactions taking place in the lower price range and (2) the aggregate value of transactions might be higher in the higher price range where transacted properties are more expensive.

FIGURE 7 Actual and counterfactual time trends of transaction volumes in the price ranges (a) £145–333k and (b) above £333k



Note: Solid lines represent the actual number of transactions in each month. Dashed lines represent the counterfactual number of transactions, calculated using predicted values from the regression model outlined above. The grey shaded area around the counterfactual represents the 95 per cent confidence interval of the counterfactual estimates. The vertical dotted lines mark the beginning and end of the excluded region. The vertical dashed line marks the introduction of the LBTT (time notch).

after April seems to be smaller when compared with the excess bunching before the tax regime change. For a surplus of 1,104 transactions in March, we only have 423 transactions missing in the next three months. There are two ways we can rationalise this finding. First, the additional transactions (or at least a share of these) might be a consequence of extensive margin responses, that is, property transactions that would not have taken place if not for the tax incentives created by the time notch. Intuitively, this behavioural response is sensible given that the sharp increase in tax liabilities after the end of March makes it particularly costly to wait around to buy a property. Plausibly, the announcement of future tax increases created such a salient incentive to buy a property (and do it quickly), that even people who were not planning to do so were encouraged to search for properties. It is also possible that the

tax incentives created by the time notch were so salient that agents brought forward transactions from months way beyond 1 April.[46]

Overall, our evidence suggests that the Scottish property market responds quickly and drastically to tax incentives created by anticipated changes in transaction tax rates. Calculating tax revenues under actual and counterfactual scenarios for both price ranges gives us an estimated £18.38 million of lost tax revenues overall during the excluded period. Similarly to our estimates in Section 4.1.1, this figure is based on the actual density of transactions that may have been affected by extensive margin responses to the time notch. Once we strip out the extensive margin responses by forcing the excess mass of transactions to be equal to the missing mass, our revenue leakage estimate reduces to £7.05 million. We can consider this estimate to correspond to the revenue leakage during the excluded period directly from the timing responses.

4.3 | Estimating the permanent effects of progressive tax reform on transaction volumes

In this subsection, we assess the effects of the LBTT on property market activity in Scotland to investigate the permanent effects of progressive transaction tax reform on different market segments. Permanent effects arise because lasting changes in transaction tax rates change the incentives of buyers and sellers to transact, thereby affecting how often properties are bought and sold.

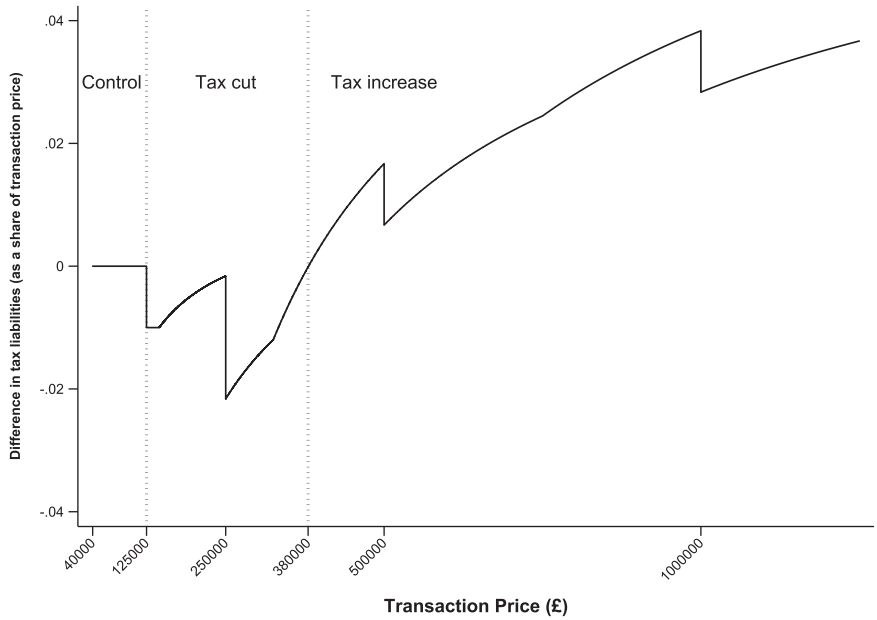
Progressive reform in Scotland should have both positive and negative effects on the property market. This is because different price ranges were affected differently by the introduction of the LBTT: while some lower price ranges saw reductions in tax rates, in higher price ranges the tax rates increased. We investigate the effects of progressive reform through a comparison, over time, of the price ranges affected and unaffected by the introduction of the LBTT. Our baseline model is

$$\begin{aligned}\ln T_{im} = {} & \alpha + \beta_1 Post_m + \beta_2 Post_m \times LBTT_{CUT} \\ & + \beta_3 Post_m \times LBTT_{INCREASE} + \sum_{i=1}^{4} \gamma_i Pre_m \times Bunching_{BELOW} \\ & + \sum_{i=1}^{4} \delta_i Pre_m \times Bunching_{OVER} \\ & + \sum_{m=1}^{3} \gamma_m Announcement_m \times Timing_{LOW} \\ & + \sum_{m=1}^{3} \delta_m Announcement_m \times Timing_{HIGH} \\ & + \theta_{year} + \theta_{month} + \theta_i + \epsilon_{im}, \end{aligned} \tag{3}$$

where our outcome variable $\ln T_{im}$ is the log number of monthly transactions in each £5,000 price bin i. The dummy $Post_m$ is an indicator for the post-LBTT (treatment) period, while the interaction terms $Post_m \times LBTT_{CUT}$ and $Post_m \times LBTT_{INCREASE}$ indicate exposure to the LBTT reform in the relevant price ranges. The terms $LBTT_{CUT}$ and $LBTT_{INCREASE}$ are dummy variables indicating price ranges

[46] Being incorporated into the counterfactual, these missing transactions could downward bias counterfactual estimates of transaction volumes for the final part of 2015. A solution to this issue would be to extend the excluded region to months near the end of 2015; however, doing so would risk bias from the announcement and introduction of the ADS in 2016 (see Section 2).

FIGURE 8 Differences in tax liabilities along the price distribution: a comparison of the previous SDLT and current LBTT regimes



Note: The dotted vertical lines indicate the break-even prices of £125k and £380k: below £380k (and above £125k) liabilities are lower under LBTT in comparison with the previous SDLT system. Above £380k, tax liabilities are higher under the LBTT. The price range between £40k and £125k is unaffected.

where the introduction of the LBTT led to a tax cut or a tax increase, respectively. The coefficients β_2 and β_3 are our coefficients of interest: β_2 measures the effect of tax cuts from the tax reform in the lower price ranges, whilst β_3 measures the effect of tax increases in the higher ranges.

We also include several dummy variables and interaction terms to control for the effects of price and time notches. First, to control for bunching around price notches in the old tax regime, we interact a dummy for the old SDLT period with the excluded regions used in our analysis in Section 4.1.1 ($Pre_m \times Bunching_{BELOW}$ and $Pre_m \times Bunching_{OVER}$). Second, we interact dummy variables denoting the excluded regions around the LBTT announcement with the tax saving categories from Section 4.2 to control for the effect of the LBTT announcement for the price ranges affected by timing responses ($Announcement_m \times Timing_{LOW}$ and $Announcement_m \times Timing_{HIGH}$). Year and month fixed effects are also included to control for year- and month-level trends in the outcome variable, while price bin fixed effects are used to control for unobservable differences in transaction market activity along the price distribution. Standard errors are clustered at the price bin level to allow for the correlation of error terms within price bins over time.

Our identification strategy relies on a panel difference-in-differences (diff-in-diff) analysis in which we compare changes in transaction numbers across price ranges affected (treated) and unaffected (control) by the LBTT reform. Selection of treated and control price ranges is based on the comparison of tax liabilities for equally priced properties, under the LBTT and previous SDLT regimes. Here, we consider the reform to be a change from the previous SDLT system to the new, more progressive LBTT regime (see Section 4.2). Figure 8 summarises the differences in tax liabilities under the current LBTT and previous SDLT tax regimes. As shown in Figure 8, we can split up our sample into three distinct price segments: £40–125k, where tax liabilities (for equally priced properties) were unaffected by the policy change; £125–380, where tax liabilities decreased under the LBTT; and above £380k, where tax liabilities increased. In our analysis, we use the price range £40–125k, unaffected by the policy change, as the 'control' group. We exclude the price range below £40k to avoid any bias from the 2016

TABLE 3 OLS results: diff-in-diff estimates

	Baseline		£10k excl.		Until 2016		Area FE	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\beta_2 Post_m * LBTT_{CUT}$	0.293***	0.274***	0.272***	0.263***	0.285***	0.272***	0.210***	0.173***
	(0.025)	(0.056)	(0.032)	(0.057)	(0.030)	(0.054)	(0.022)	(0.040)
$\beta_3 Post_m * LBTT_{INCREASE}$	0.080***	0.036	0.055*	0.019	0.018	−0.013	0.004	−0.046
	(0.026)	(0.042)	(0.032)	(0.043)	(0.036)	(0.047)	(0.024)	(0.038)
Observations	11,483	11,483	11,276	11,276	7,526	7,526	72,763	72,763
R^2	0.956	0.952	0.956	0.952	0.955	0.951	0.745	0.741
Controls	Yes	No	Yes	No	Yes	No	Yes	No
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Price bin fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Area fixed effects	No	No	No	No	No	No	Yes	Yes

Note: Robust standard errors in parentheses. Standard errors are clustered at the price bin level. Columns 1 and 2 show estimates for our baseline specification in model 1. Columns 3 and 4 show estimates for the robustness check where the £10k price ranges around kink points are excluded to control for spillover effects between price ranges. Columns 5 and 6 show estimates for the robustness check where months after 2015 are excluded. Columns 7 and 8 show estimates for the robustness check where we include postcode area fixed effects to account for regional heterogeneity in transaction market activity. The level of observation in Columns 1–6 is price bin–month. In Columns 7 and 8, the level of observation is postcode area–price bin–month. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

introduction of the ADS, an additional surcharge payable for all second homes priced above £40k.[47] Our 'treated' price ranges (i.e. those affected by the LBTT reform) are the price range £125–380k, where tax liabilities decreased, and above £380k, where tax liabilities increased. Average tax savings from the LBTT in the 'tax cut' range were equal to roughly £1,600 (or 0.8 per cent of average property value in this market segment), while average losses from the LBTT in the 'tax increase' range were equal to roughly £7,800 (or 1.2 per cent of property value).[48] However, also note that the tax cuts affected a much higher number of potential transactions when compared with the tax increases.[49] In the online Appendix, we show that transactions in the treated and control ranges followed a similar pre-reform path, with the exception of a small deviation in mid-2014. We lend further validity to the parallel trends assumption – conditional on common seasonal trends – through event study estimations in Section 4.3.1.

Our diff-in-diff model is estimated using ordinary least-squares (OLS) and the results are presented in Table 3. Several robustness checks are carried out to test the sensitivity of estimates to changes in the model specification. First, we exclude the £10k price ranges around the £125k and £380k tax liability thresholds to control for possible spillovers between neighbouring price ranges.[50] Second, we exclude months from after December 2015 to check whether our estimates are sensitive to the introduction of the ADS. Finally, we disaggregate our data at the Scottish Postcode Area level and use

[47] It is possible that the introduction of the ADS had an unequal effect across the price distribution. The timing responses to the ADS introduction, which were substantial in all three distinct price ranges (see Figure B.1 in the online Appendix) seem to suggest a similar effect along the price distribution but we are unable to rule out heterogeneous effects as we cannot observe ADS transactions directly. Nonetheless, to check whether our results are sensitive to the inclusion of the ADS period in our sample, we run an additional robustness check below.

[48] These calculations are based on the estimated tax savings for the actual transactions that occurred during the LBTT period.

[49] According to the forecasts of the Scottish Government, 90 per cent of home buyers should pay lower tax (or the same tax) under the LBTT (Scottish Government, 2013b). According to our own calculations, in the post-LBTT period, roughly 52 per cent of transactions paid lower taxes than they would have under the previous system, 5 per cent paid higher taxes, and the remaining 43 per cent paid the same amount (usually zero).

[50] One potential source of spillover effects may be the presence of real estate chains; that is, buyers of properties simultaneously selling existing properties at slightly different prices leading to an increase in transaction activity in adjacent price ranges (Best and Kleven, 2018).

area fixed effects to control for potential regional heterogeneity.[51] Results from robustness checks are presented in Columns 3–8 of Table 3.

Overall, the estimates presented in Table 3 are indicative of a significant (and robust) aggregate level effect of the reform over the price range £125–380k, where transaction taxes were reduced. The point estimates for this price range span between 0.173 and 0.293, indicating that, on average and relative to the control group, the LBTT reform has led to a permanent increase in transaction volumes of 17.3–29.3 per cent, or equivalently, an increase of 10.9–18.2 per cent per £1,000 reduction in tax liability. Conversely, estimates relating to the price range above £380k, where tax liabilities increased under the LBTT, are small and mostly insignificant.[52]

4.3.1 | Event study specification

In this subsection, we modify our baseline specification in equation 3 and interact our reform exposure dummies with month fixed effects. This specification, a variant of an event study design[53] serves two purposes: (1) interacting the reform exposure dummies with all post-reform months allows us to assess the reform's effect over time; (2) pre-reform point estimates allow us to evaluate whether there are significant pre-treatment differences in transaction activity between treated and control price ranges.

In this specification, point estimates for the treated price ranges correspond to differences in log transaction numbers between the treated and control groups relative to the same differences in a baseline month, conditional on covariates and fixed effects, for each month of the sample.[54] These point estimates are plotted in Figures 9(a) and 9(b), for the 'tax cut' and 'tax increase' price ranges, respectively. We exclude the price range between £333k and £380k as this might have been differentially affected by timing and permanent responses.[55]

In Figure 9(a), the positive effect of the reform on transaction volumes is evident from the consistent (and significant) positive point estimates after the introduction of the LBTT. The pre-reform mean of the point estimates is not significantly different from zero at 0.044 (SE: 0.093), while the post-reform mean of 0.269 (SE: 0.094) is significant at the 1 per cent level. This mean difference suggests that the overall effect observed in Figure 9(a) is similar in magnitude to the estimates presented in Table 3. The effect of the LBTT also seems to be a long-term one, given that it does not diminish over time. In the pre-announcement period, there are only three significant point estimates. This is not a threat to the parallel trends assumption as estimates for all other months (and the pre-reform mean) are insignificant and the significant estimates for outlier months might be random, or a consequence of some exogenous shock to transaction activity in the treated price ranges.[56] Moreover, the post-reform point estimates are considerably larger and more consistent over time than pre-reform point estimates, providing reliable evidence to causally relate these effects to the reform itself.

[51] Disaggregating by postcode areas reduces the number of transactions we can include by approximately 3 per cent due to missing data on postcode areas for some of our sample. Missing information on postcode areas does not seem to be correlated with where a property is located, suggesting that there is no structural bias when disaggregating.

[52] The only point estimate that is significant at the 1 per cent level is for the baseline model (Column 1), showing a positive effect from the LBTT reform, but this finding lacks robustness as point estimates either change sign or are insignificant in other specifications.

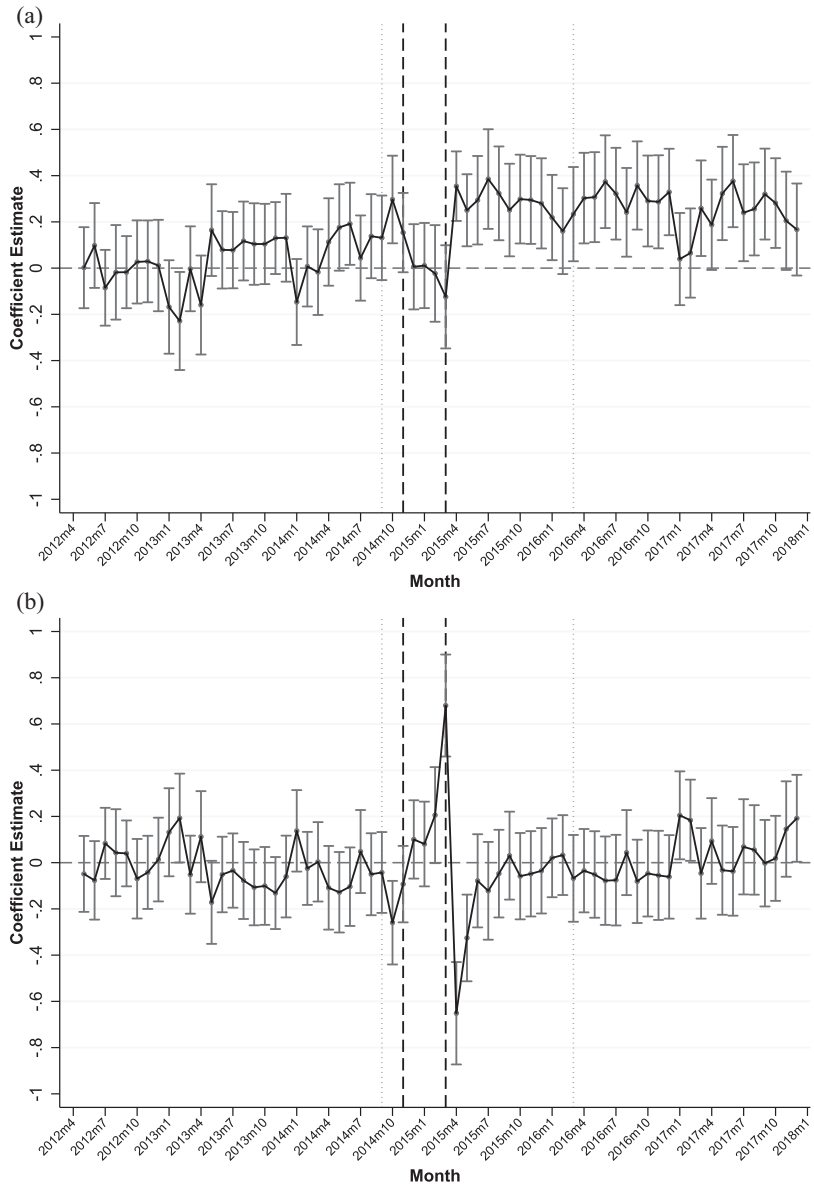
[53] For an overview of the panel event study methodology, see Clarke and Tapia Schythe (2020).

[54] The baseline month in this case is the first month in the sample (April 2012).

[55] This is because in this price range, there was a short-term incentive to bring transactions forward before April 2015 but the permanent change (when comparing the previous stamp duty system and LBTT) was a tax cut. Strangely, this means that for home buyers ready to transact in the months near April 2015 there was a short-term incentive to 'avoid' the permanent tax cut and pay even lower taxes on their transactions under the temporary tax regime.

[56] A potential source of bias in this period is from the introduction of the Help-to-Buy (HTB) scheme, a government initiative designed to provide small loans for properties under £400k. The scheme was started in October 2013 and should affect all price ranges below the limit to an equal extent (while higher ranges were excluded as wealthy home buyers have more ability to pay). To check if HTB biases our results, we run a robustness check where we include an HTB dummy for the affected price ranges and time period. This modification does not change our results to any extent.

FIGURE 9 Event study estimates for price ranges £125–333k (top) and above £380k (bottom)

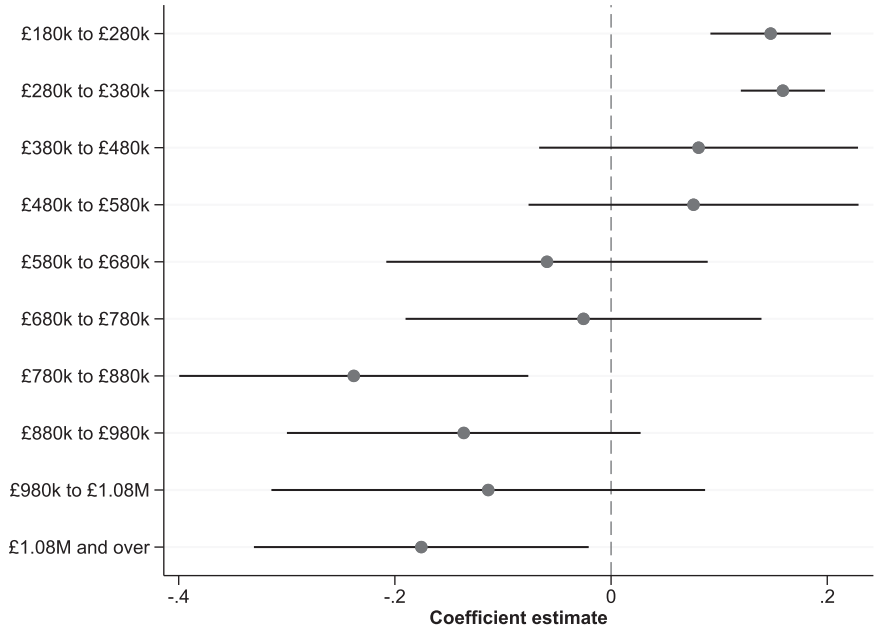


Note: The top and bottom panels show point estimates for each month interacted with the treated price range £125–333k and above 380k, respectively. Significance is indicated by the 95 per cent confidence interval (vertical bars) not spanning zero. The vertical dotted line before October 2014 indicates the initial LBTT announcement; the vertical dashed lines indicate the period between the announcement of the LBTT rates and their introduction; and the vertical dotted line before April 2016 indicates the introduction of ADS.

For the price range above £380k, the event study estimates provide no evidence of a significant post-reform effect on transaction activity (see Figure 9b). The only significant point estimates are for months immediately after the introduction of the new tax regime, in a period where markets are likely still recovering from the timing responses in the previous months (see Section 4.2).[57]

[57] Both the timing response in March 2015, and the subsequent missing transactions are evident from the event study plot in Figure 9(b). Note, however, that the point estimates are not directly comparable to our estimates in Section 4.2, as the latter use a different sample and counterfactual.

FIGURE 10 Treatment effect by price range



Note: This plot shows point estimates for each price range interacted by the LBTT (post-reform) period. Significance is indicated by the 95 per cent confidence intervals (horizontal lines) not spanning zero. Statistically significant differences between point estimates are indicated by the respective confidence intervals not spanning each other. The price range £125–180k is excluded to avoid multicollinearity.

Pre-announcement point estimates are insignificant and close to zero, indicating no violation to the parallel trends assumption. Overall, while most point estimates in the post-reform period are negative, indicating reduced transaction volumes from progressive reform, neither of these estimates is significant and therefore we find no evidence of a permanent effect on the price range where tax rates increased.

4.3.2 | Testing for the heterogeneity of treatment effects across price ranges

Our third specification attempts to quantify the property market effects of the LBTT reform along the price distribution. To identify these effects, we modify our baseline specification in equation 3 by interacting the post-reform dummy $Post_m$ with price range dummies for the £100k price ranges on both sides of the £380k tax savings cut-off (see Figure 8).

Results are summarised using the coefficient plot in Figure 10. The plot shows point estimates for each price range interacted with the post-reform dummy, along with 95 per cent confidence intervals. Confidence intervals (horizontal lines) not spanning zero are indicative of significant estimates. Overall, the results summarised in Figure 10 tell a clear story: the point estimates get smaller, and change sign, as we move through the price distribution. The initial positive (and significant) effects from the reform in the lower price ranges (where tax rates decreased) are not surprising given that our aggregate level estimates from the last two subsections were indicative of a similar positive effect. In a similar vein, the observed negative point estimates for the higher end of the market, albeit not significant apart from the price ranges £780–880k and above £1.08 million, are perfectly sensible given that progressive reform led to the largest increases in tax rates in this market segment. However, this negative effect was only really felt in the top end of the market, as our estimates suggest that the price range £380–780k was largely unaffected.

Based on our calculations, the top segment of the market above £780k contributed 6.7 per cent of the aggregate value of transactions during the old stamp duty period, while the £125–380k market segment contributed a much larger share, 58.4 per cent. Under the LBTT, these shares are 3 per cent and 64 per cent, respectively. The top end of the market also makes up less than half of the lower end's share of tax revenue contributions in both periods.[58]

This suggests that even if we conjecture, in percentage terms, that the negative effects of the LBTT on the top end of the market offset the positive effects on the lower end, in value-weighted terms, the positive effects should outweigh the negative effects as they apply to a market segment with a higher aggregate value of transactions.

5 | DISCUSSION

In general, taxation of property transactions is not optimal.[59] In Scotland, this suboptimality currently arises for (at least) two reasons: (1) transaction taxes discourage an otherwise beneficial economic activity; and (2) agents are highly responsive to them, leading to large welfare costs (deadweight losses) from behavioural responses. Nonetheless, our results suggest that recent policy changes in Scotland were successful in limiting overall distortions from the transaction tax system. In the following, we reflect on our findings in more detail.

(a) Price notches and kinks

Our analysis of the previous stamp duty regime shows that the 'notched' design of that system had a considerable distortionary effect on the Scottish property market showing up in bunching of transactions. These bunching responses are likely a result of agents manipulating prices in order to move into lower tax bands and avoid the abrupt increase in tax liabilities at specific price notches. Overall, our findings are in line with the predictions of the theoretical literature and prior empirical results.[60]

Contrary to the case of the previous SDLT regime, we find only limited evidence of bunching under the 'kinked' LBTT system. Bunching responses are only apparent in transactions close to the £250k and £750k kinks, and magnitudes are smaller than for the bunching responses observed at notches. Possibly, the fact that we observe bunching responses only at these kink points and not others (£145k and £325k) is a result of these kinks providing more salient reference points for agents to strive towards.[61] Overall, we can say that the removal of price notches led to a simple and more sensible tax system, where manipulation of prices to avoid paying higher taxes is incentivised to a far lesser extent. Consequently, our evidence suggests that replacing the notched structure of stamp duty with a kinked one was a sensible policy of the Scottish Government. Given the responsiveness of agents and the associated distortions to the property market, our recommendation is that notches should be avoided in future stamp duty regimes.

(b) Time notches

Our findings in Section 4.2 provide evidence that Scottish agents are highly responsive to the presence of time notches and they will time transactions in order to realise tax savings. These responses result in lower tax revenues for the government as the inter-temporal substitution of transactions leads to more transactions being taxed under the more generous tax regime. In Scotland, time notches are likely to continue to emerge upon the introduction and announcement of new tax policies. The savings

[58] Under the LBTT, the price range above £780k contributes roughly 17.5 per cent of tax revenues while the market segment between £125k and £380k contributes 38 per cent.

[59] Mirrlees et al., 2011.

[60] Kopczuk and Munroe, 2015; Kleven, 2016; Slemrod et al., 2017; Best and Kleven, 2018.

[61] See Kleven (2016).

opportunities provided by these notches are usually present for roughly four months, as policies announced in December are generally implemented the following April – announcement windows of this length provide ample time for agents to re-time transactions. The current devolved context means that Scottish budget setting procedures are complicated by their reliance on UK budgetary procedures;[62] institutional constraints prohibit the government from creating shorter announcement windows for policy changes.[63] Consequently, in the Scottish case, distortions from time notches are an unintended consequence of the devolved fiscal setting. As long as these institutional arrangements are in place, transaction tax changes are going to be anticipated, announcement periods will remain lengthy, and timing responses will likely continue to cause large temporary distortions to market activity. To mitigate the effects of time notches on the property market, policymakers need to account for the nature and extent of associated distortions when designing and implementing new policies. Our estimates of timing responses (and corresponding estimates for behavioural elasticities) could therefore be useful to policymakers attempting to forecast the distortionary effects of future policy announcements.

(c) Permanent effects of progressive transaction tax reform

Our finding that progressive LBTT reform has led to an increase in transaction activity in the lower end of the market is consistent with the government's objective to encourage transaction activity in lower price ranges.[64] One explanation for the sizeable effect observed in this price range is that, according to the theoretical model in Best and Kleven (2018), low-income home buyers (especially first-time buyers) are likely to be highly leveraged and constrained by mortgage downpayments, increasing their responsiveness to transaction taxes that need to be paid upfront. It is therefore possible that higher transaction tax rates in the past led to a permanent 'lock-in' effect, with transactions in lower price ranges not taking place due to the pressure transaction taxes put on downpayment-constrained agents with low incomes.

Our findings also suggest that progressive tax reform did not have an overall significant negative effect on the transactions in the higher price ranges where tax rates increased. More substantial negative effects from the tax reform only appear towards the most expensive segment of the market (over £780k) which has a smaller contribution to the aggregate value of property market transactions than the lower end of the market.

From a policy perspective, these findings are promising, as the boost to market activity at the lower end of the price distribution was not offset by a similarly sized negative response at the higher end of the market. In other words, the intended positive effects introduced by progressive reform are seemingly larger, in relative terms, than the negative effects. Assuming that political constraints render abolition (or comprehensive cuts) infeasible, this finding suggests that progressive reform could potentially be a 'second-best' policy option that can achieve efficiency gains for the vast majority of property market participants without causing unwanted distortions in transaction volumes and tax revenues in the other parts of the market. In general, whether there are efficiency gains to be made from progressive reform should depend on the relative responsiveness of different market segments to changes in tax rates – this is equivalent to an 'inverse-elasticity rule', which would postulate that, to minimise distortions, more responsive market segments should be taxed at lower rates, and vice versa.[65]

Nonetheless, some important caveats are worth noting before we use these results as the basis for generic policy recommendations. First, it is unclear whether the differences in responsiveness that

[62] Eiser, 2017.

[63] This is due to the procedure of block grant adjustments whereby, each year, the fiscal support from the UK government (block grant) is adjusted to take into account the tax revenues raised from devolved taxes in Scotland. This means that the proposed Scottish budget has to be announced early to allow the forecasting of tax revenues from devolved taxes and the resulting adjustments to the block grant from the UK (Eiser, 2017).

[64] Scottish Government, 2013b.

[65] Sandmo, 1976.

we observe across the price distribution are a consequence of transactions in lower price segments being more responsive to all types of tax changes than higher ones, or the lower segment being more responsive to a tax cut than the higher one is to a tax increase. If agents across the price distribution are more responsive to tax cuts than they are to tax increases, then responsiveness is endogenous to the sign of the tax change and the inverse-elasticity rule becomes self-fulfilling. Furthermore, even if agents were equally responsive to tax cuts and tax increases, it would be difficult to use our results to determine the optimal degree of progressivity for the transaction tax system. What our analysis of Scottish reform tells us is that in aggregate, the responses to progressive reform are consistent with a desirable policy outcome. It is also plausible that further increases in progressivity would have a similar effect. In fact, any increase in progressivity will likely lead to an efficiency gain given the differences in marginal responsiveness to changes in progressivity along the price distribution. As long as there are differences in marginal responsiveness, tax cuts in some part of the price distribution will be more (positively) distortive to transactions than tax increases in another part. In the case of Scotland, we can therefore conclude that while initial progressive reform has led to some efficiency gains via the large relative stimulus effect in the lower end of the market, it is unclear whether further improvements could be made and more advanced theoretical and empirical frameworks are needed to assess this.

Overall, our evidence on permanent effects suggests that because of the responsiveness of Scottish agents, cuts in transaction taxes can be used rather effectively to stimulate the property market, even outside periods of economic downturns.[66] Furthermore, our evidence on the effects of progressive reform suggest that progressive changes in transaction tax schedules could also be effective in achieving redistributive goals given minimal distortions to the market segments where tax rates increase and the boost to transaction activity in the lower end of the market, which includes the majority of Scottish home buyers (see Section 4.3). These results may be driven by a number of desirable economic mechanisms. For example, reduced moving costs due to lower tax rates could facilitate job search by making it less costly to relocate in search of employment.[67] Increased mobility may also mean that lower tax rates encourage retired households to downsize, leading to a better allocation of the housing stock in terms of the optimal amount of space needed for households.[68] Nonetheless, our analysis does not directly identify these effects and further research is needed to examine the mechanisms that drive our results.

6 | CONCLUSIONS

We have studied the distortionary effect of four distinct features of recent Scottish transaction tax systems: (1) the presence of price notches in the previous stamp duty system; (2) the existence of kink points in the LBTT system; (3) the appearance of a time notch corresponding to the April 2015 introduction of the LBTT; and (4) the shift to the more progressive LBTT regime.

Using a bunching estimator methodology, whereby we estimate counterfactual transaction densities for each price range, we find clear evidence of the bunching of transactions around price notches in the previous stamp duty system. In contrast, we find limited evidence of bunching at (some) kink points under the LBTT, but these responses are smaller and less significant than the bunching found for the previous (notched) transaction tax system. We further find evidence that the temporary tax saving opportunity created by the early announcement of LBTT rates resulted in large-scale re-timing of property transactions. Finally, studying the effects of progressive reform across the entire price distribution, we find that the LBTT had a substantial positive effect on transaction activity in the

[66] For evidence on the fiscal stimulus effect of transaction tax cuts during periods of economic downturns, see Besley et al. (2014) and Best and Kleven (2018).

[67] Mirrlees et al., 2011.

[68] Glaeser and Luttmer, 2003.

market segment in which tax rates decreased, and only a limited negative effect at the higher end of the market where tax rates increased, indicating that the latter part of the market was less responsive to progressive tax reform.

Overall, our results suggest that the Scottish property market is highly responsive to changes in transaction taxes, and is particularly responsive to tax saving opportunities available due to the presence of notches in the tax system. While, overall, transaction taxes are distortionary to property market behaviour, tax policy should focus on mitigating their effects on economic behaviour. Removing price notches from the Scottish tax system was therefore a sensible policy, but time notches continue to emerge as a result of institutional arrangements related to Scotland's devolved policy setting. In addition, behavioural responses to the LBTT reform suggest that progressive changes to transaction tax system should be encouraged if they induce transaction activity in lower market segments more than they reduce activity in higher segments.

The evidence from our analysis also suggests that because of the high degree of responsiveness to transaction tax changes, cuts to these taxes can be used very effectively to stimulate activity in the property market. This boost to the property market is likely driven by behavioural responses that are desirable for the housing and labour market outcomes of households. Future research should focus on directly identifying these household-level behavioural responses to changing transaction tax rates.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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